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(12) # EUROPEAN PATENT SPECIFICATION

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(54) **Coin discriminator.**

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EP-A- 0 119 000
GB-A- 2 041 532
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EP 0 300 781 B1

Description

This invention relates to coin discriminators. The term "coin" is intended to cover coin-like items such as bogus coins, tokens and circular blanks.

Discriminators employing one or more coils for inductively linking with the coin under test have been used. It has been proposed in Patent Specification G.B. No. 2 041 532A to subject a coil to a voltage pulse and then to monitor the decay of eddy currents produced in a coin by the pulse, in order to test the electrical characteristics of the coin. The decay signal is sampled at predetermined times and is compared with stored reference values appropriate to those times in order to determine the coin type (cf. also EP-A-0 119 000).

We have now realised that it is advantageous to set two voltage levels for the eddy current detection means and to measure the times at which the voltage levels are passed, and to use those times to characterise the coin. One advantage is that there is no need to use an analogue to digital converter, thereby leading to a cost saving.

According to one aspect of the invention a coin discriminator comprises a coin path along which a coin under test is arranged to pass, a coil means positioned adjacent to the coin path, electrical means for subjecting the coil means to a voltage pulse, eddy current detection means adapted to detect the decaying eddy currents induced in the coin by pulsing of the coil means, and monitoring means arranged to detect when the output of the eddy current detection means reaches a first predetermined level and then a second predetermined level, and comparison means for comparing at least one time measurement made by the monitoring means with reference times to determine whether or not there is a concordance between the measured time and a corresponding reference time.

Preferably the times at which the output of the eddy current detection means reaches the first and second levels are each compared with respective reference times, and a concordance between both measured times and corresponding reference times is taken as an indication of a coin type.

A problem with the method of G.B. 2 041 532 is that the proximity of the coin to the test coil/coils affects the magnitude of the eddy currents, and for various reasons some coins may proceed past the test coil/coils at a greater distance from the coil/coils than other coins, for example due to bouncing of the coins. This can lead the discriminator to assign an incorrect value to the coin.

According to a second aspect of the invention a coin discriminator comprises a coin path along which a coin under test is arranged to pass, a coil means positioned adjacent to the coin path, electrical means for subjecting the coil means to a voltage pulse, eddy current detection means adapted to detect the decaying eddy currents induced in the coin by pulsing of the coil means, and monitoring means arranged to measure the time taken for the output of the eddy current detection means to fall from a first predetermined level to a second predetermined level, and comparison means for comparing said time with a reference time to determine whether or not there is a concordance between the measured time and the reference time.

As is known, the eddy current detection means may comprise a sampling coil which is additional to the coil means, or the coil means may itself constitute a sampling coil.

The coil or coils are preferably arranged to be substantially critically damped.

Two coin discriminators in accordance with the invention will now be described, by way of example only, with reference to the accompanying schematic drawings in which:-

Figure 1 is a cross-section through the coin passage of a first discriminator in accordance with the invention showing the single coil;

Figure 2 is a graph showing the coil voltage against time;

Figure 3 is an enlarged version of a graph similar to Figure 2 showing curves produced by a coin at two different distances from the coil;

Figure 4 is a plot of the timing pulse produced by a window detector from one of the curves in Figure 3;

Figure 5 is a block circuit diagram of a second discriminator in accordance with the invention; and

Figure 6 shows plots of signals at various locations in the circuit of Figure 5.

In Figure 1 a single coil 1 is shown mounted in a recess in a non-magnetic support surface or wall 2 defining one side 3 of a coin passage of the discriminator. The coil is, for example, of diameter 2mm and is wound on a ferrite core, the axis of the coil being arranged substantially normal to the surface 3.

Only a single coil 1 is used in this embodiment, the coil 1 being connected both to a pulse circuit and to a monitoring circuit, not shown.

In Figure 2 the coil voltage of the coil 1 is shown, the decay curves (a) and (b) corresponding to voltages induced in the coil by the magnetic field which is produced by the decaying eddy currents, a coin of a conductive material being present for curve (a) but with no coin for curve (b). The flat top 4 to the curve is due to the saturation of the amplifier of the monitoring circuit.

As shown in Figure 1 a coin may proceed along the coin passage in contact with surface 3 as

coin 5, or it may be spaced from surface 3, as coin 6. Figure 3 shows two superimposed plots (c) and (d) of the coil voltage due to identical coins which are respectively positioned against surface 3 and away from surface 3. It will be seen that the shapes of the decay portions of the curves (c) and (d) are closely similar, but that the curve (c) represents greater induced voltages than curve (d).

We have appreciated that if an adjustment can be made for that difference in overall voltage level the position of the coin in relation to surface 3 will not matter to the same degree.

In accordance with the second aspect of the invention this adjustment is achieved by setting two voltage thresholds levels V_1 and v_2 and measuring the time T_2-T_1 for the coil voltage to fall from V_1 to V_2. The time T_2-T_1 is not significantly different for the two curves (c) and (d), but the corresponding time would be different for a coin of a different type. Figure 4 shows how with a window detector a rectangular pulse of length T_2-T_1 can be generated for the curve (c). The duration of the pulse T_2-T_1 is then compared with a series of stored reference values of the time difference to determine the conductivity characteristics of the coin.

In situations in which the coins can be kept in close proximity to the surface 3 the curves of induced coil voltage will have sufficiently consistent parameters to enable the coin types to be characterised by the times T_1 and T_2 measured separately, the measured times T_1,T_2 being compared with stored reference sets of T_1 and T_2 to determine the coin type.

Figure 5 is a block circuit diagram of a second discriminator in accordance with the invention in which times T_1 and T_2 are separately measured.

A microcomputer applies a drive pulse, signal A (Figure 6), to an electronic switch 8 to pulse coil 1. The detector coil voltage, signal B, is amplified by amplifier 9 and the amplified signal C is compared with two reference voltage levels V_1 and V_2 by comparators COMP 1 and COMP 2 respectively, the voltage levels V_1 and V_2 being set on a potential divider.

The microcomputer 7 incorporates a timing function and is programmed to time the occurrence of the pulse edges produced in the outputs, signals D and E, from the comparators COMP 1 and COMP 2, to provide measurements of the times T_1 and T_2. The microcomputer then compares the measured times T_1 and T_2 with stored reference sets to determine the coin type. For each coin type the reference set will comprise maximum and minimum values of T_1, and maximum and minimum values of T_2.

Such discriminators are preferably used in conjunction with other discriminators which measure, for example, coin diameter and coin thickness, to provide an accurate determination of the coin type.

Claims

1. A coin discriminator comprising a coin path (3) along which a coin (5) under test is arranged to pass, a coil means (1) positioned adjacent to the coin path, electrical means (8) for subjecting the coil means to a voltage pulse, and eddy current detection means (9) adapted to detect the decaying eddy currents induced in the coin by pulsing of the coil means, characterised by monitoring means (COMP 1, COMP 2, 7) arranged to detect when the output of the eddy current detection means reaches a first predetermined level (V_1) and then a second predetermined level (V_2), and comparison means (7) for comparing at least one time measurement (T_1,T_2) made by the monitoring means with reference times to determine whether or not there is a concordance between the measured time and a corresponding reference time.

2. A coin discriminator as claimed in claim 1 in which the times at which the output of the eddy current detection means reaches the first and second levels (V_1,V_2) are each compared with respective reference times, and a concordance between both measured times (T_1,T_2) and corresponding reference times is taken as an indication of a coin type.

3. A coin discriminator comprising a coin path (3) along which a coin (5) under test is arranged to pass, a coil means (1) positioned adjacent to the coin path, electrical means (8) for subjecting the coil means to a voltage pulse, and eddy current detection means (9) adapted to detect the decaying eddy currents induced in the coin by pulsing of the coil means, characterised by monitoring means (COMP 1, COMP 2, 7) arranged to measure the time taken (T_2-T_1) for the output of the eddy current detection means to fall from a first predetermined level (V_1) to a second predetermined level (V_2), and comparison means for comparing said time (T_2-T_1) with a reference time to determine whether or not there is a concordance between the measured time and the reference time.

4. A coin discriminator as claimed in any of the preceding claims in which the coil means is arranged to be substantially critically damped.

Patentansprüche

1. Münzendiskriminierer mit der Münzenbahn (3), entlang welcher eine zu prüfende Münze (5) zum Durchlaufen angeordnet ist, mit einer nahe der Münzenbahn angeordneten Spuleneinrichtung (1), mit einer elektrischen Einrichtung (8), welche die Spuleneinrichtung mit einem Spannungsimpuls beaufschlagt, sowie mit einer Wirbelstromerfassungseinrichtung (9), mittels welcher die in der Münze durch Impulsgabe induzierten abklingenden Wirbelströme erfaßbar sind, **gekennzeichnet** durch eine Überwachungseinrichtung (COMP 1, COMP 2, 7), die so angeordnet ist, daß erfaßt, wenn das Ausgangssignal der Wirbelstromerfassungseinrichtung einen ersten vorgegebenen Pegelwert (V_1) und anschließend einen zweiten vorgegebenen Pegelwert (V_2) erreicht, sowie durch eine Vergleichseinrichtung (7), welche mindestens eine von der Überwachungseinrichtung gemessene Zeit (T_1, T_2) mit Bezugszeiten vergleicht, um festzustellen, ob Übereinstimmung zwischen der gemessenen Zeit und einer enprechenden Bezugszeit vorliegt oder nicht.

2. Münzendiskriminierer nach Anspruch 1, bei welchem die Zeitpunkte, zu denen das Ausgangssignal der Wirbelstromerfassungseinrichtung den ersten und zweiten Pegelwert (V_1, V_2) erreicht, mit jeweiligen Bezugszeitpunkten verglichen werden, und eine Übereinstimmung zwischen beiden gemessenen Zeiten (T_1, T_2) und enprechenden Bezugszeiten als Hinweis auf eine Münzart aufgefaßt wird.

3. Münzendiskriminierer mit einer Münzenbahn (3), entlang welcher eine zu prüfende Münze (5) zum Durchlaufen angeordnet ist, mit einer nahe der Münzenbahn angeordneten Spuleneinrichtung (1), mit einer elektrischen Einrichtung (8), welche die Spuleneinrichtung mit einem Spannungsimpuls beaufschlagt, sowie mit einer Wirbelstromerfassungseinrichtung (9), mittels welcher die in der Münze durch Impulsgabe induzierten abklingenden Wirbelströme erfaßbar sind, **gekennzeichnet** durch eine Überwachungseinrichtung (COMP 1, COMP 2, 7), die so angeordnet ist, daß sie die Zeitdauer (T_2-T_1) erfaßt, welche das Ausgangssignal der Wirbelstromerfassungseinrichtung zum Abfallen von einem ersten vorgegebenen Pegelwert (V_1) auf einen zweiten vorgegebenen Pegelwert (V_2) benötigt, sowie durch eine Vergleichseinrichtung (7), welche die Zeitdauer (T_1-T_2) mit einer Bezugszeitdauer vergleicht, um festzustellen, ob Übereinstimmung zwischen der gemessenen Zeitdauer und der Bezugszeitdauer vorgliegt oder nicht.

4. Münzendiskriminierer nach dem der vorhergehenden Ansprüche, bei welchem die Spuleneinrichtung so angeordnet ist, daß sie im wesentlichen kritisch gedämpft wird.

Revendications

1. Un discriminateur de pièces de monnaie comprenant un chemin (3) de pièce de monnaie pour le passage d'une pièce (5) sous test, des moyens de bobine (1) positionnés à proximité du chemin de pièce de monnaie, des moyens électriques (8) pour soumettre les moyens de bobine à une impulsion de tension, et des moyens de détection (9) d'un courant de Foucauld adaptés à détecter les courants de Foucauld décroissants induits dans la pièce de monnaie par le passage d'impulsions dans les moyens de bobine, caractérisé en ce qu'il comporte des moyens de surveillance (COMP 1, COMP 2, 7) adaptés pour détecter le moment où le signal de sortie des moyens de détection de courant de Foucauld atteignent un premier niveau prédéterminé (V_1) et ensuite un deuxième niveau prédéterminé (V_2), et des moyens de comparaison (7) pour comparer au moins la mesure de temps (T_1, T_2) mise par les moyens de surveillance avec des durées de référence afin de déterminer si ou non il y a une concordance entre l'intervalle de temps mesuré et une durée de référence correspondante.

2. Un discriminateur de pièces de monnaie selon la revendication 1, dans lequel les instants auxquels le signal de sortie des moyens de détection des courants de Foucauld atteignent les premier et deuxième niveaux (V_1, V_2) sont chacun comparés aux instants respectifs de référence, et une concordance entre les deux instants mesurés (T_1, T_2) et des instants correspondants de référence est adoptée comme indication d'un type de pièce de monnaie.

3. Un discriminateur de pièces de monnaie comprenant un chemin (3) de pièce de monnaie pour le passage d'une pièce (5) sous test, des moyens de bobine (1) positionnés à proximité du chemin de pièce de monnaie, des moyens électriques (8) pour soumettre les moyens à bobine à une impulsion de tension, et des moyens de détection (9) d'un courant de Foucauld adaptés à détecter les courants de Foucauld décroissants induits dans la pièce de monnaie par le passage d'impulsions dans les moyens de bobine, caractérisé en ce qu'il comporte des moyens de surveillance (COMP 1, COMP 2, 7) adaptés pour mesurer le temps

écoulé (T_2 - T_1) nécessaire pour le passage des moyens de détection de courant de Foucauld d'un premier niveau prédéterminé (V_1) à un deuxième niveau prédéterminé (V_2) détectés, des moyens de comparaison étant prévus pour comparer cet intervalle de temps (T_2 - T_1) avec un intervalle de référence afin de déterminer si ou non il y a concordance entre l'intervalle mesuré et l'intervalle de référence.

4. Un discriminateur de pièces de monnaie selon l'une quelconque des revendications précédentes, dans lequel les moyens de bobine sont disposés afin d'être amortis sensiblement de manière critique.

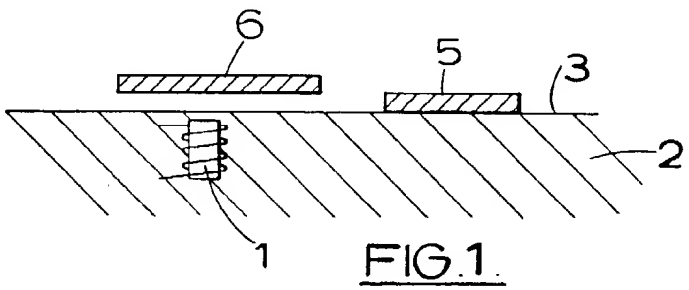

FIG.1.

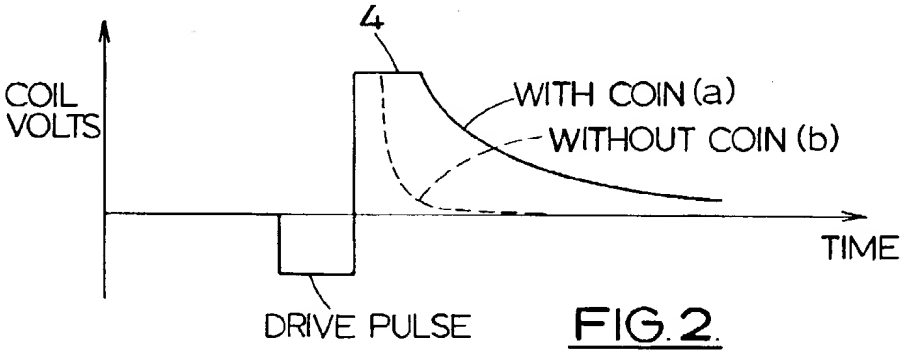

FIG.2.

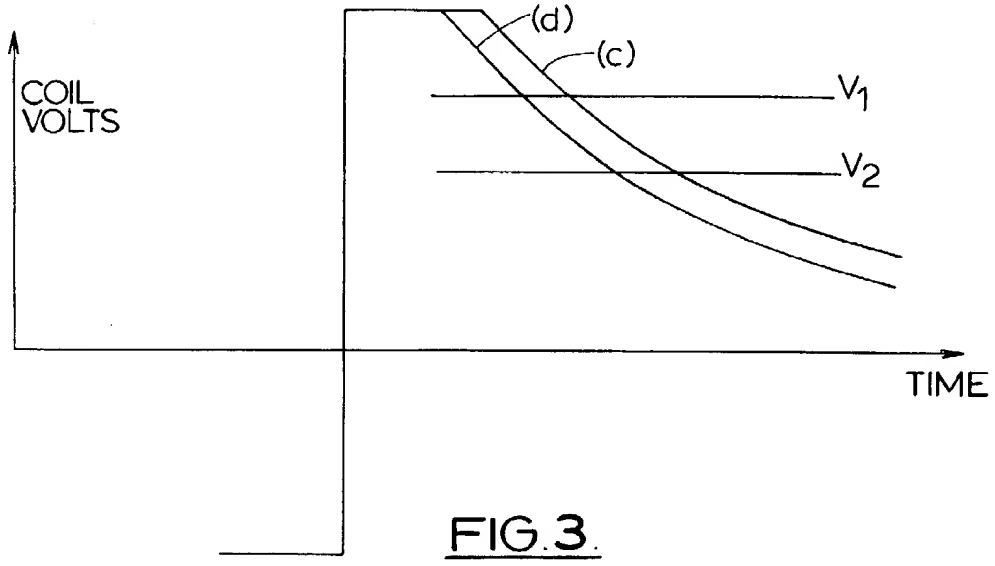

FIG.3.

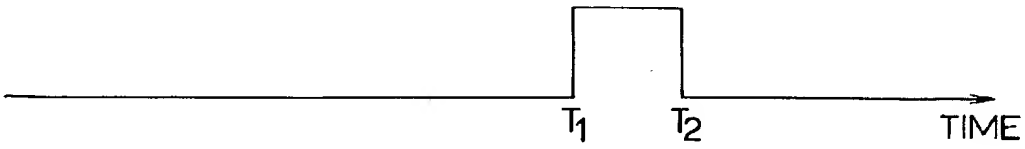

FIG.4.

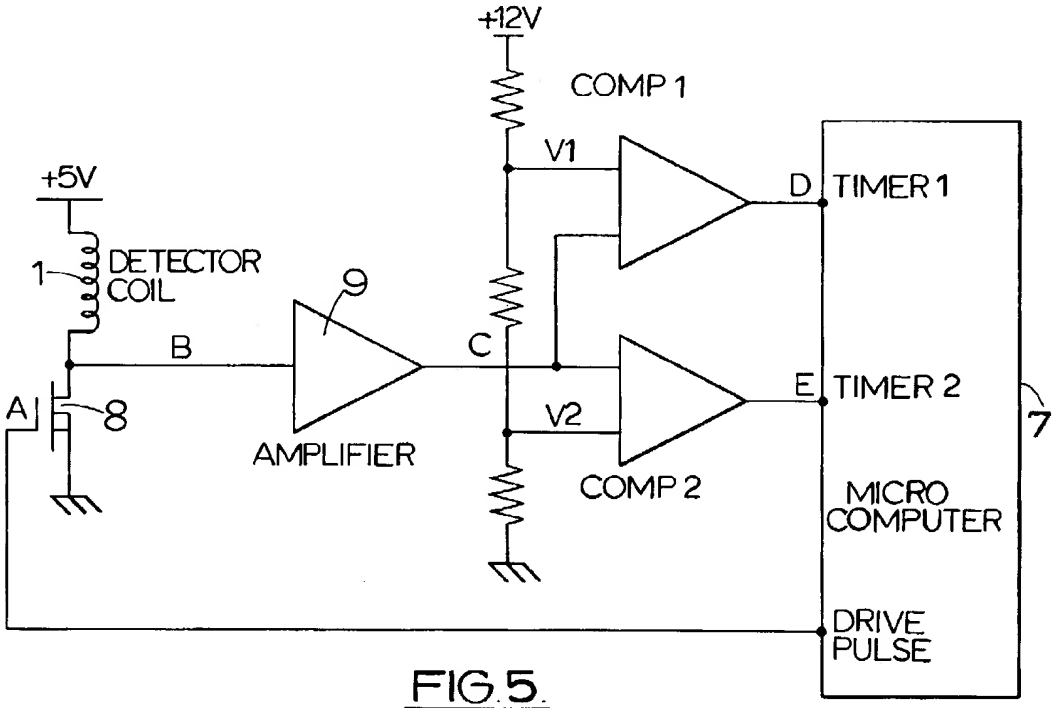
+12V
COMP 1
V1
+5V
D
TIMER 1
1
DETECTOR
COIL
9
B
C
E
TIMER 2
A
8
V2
7
AMPLIFIER
COMP 2
MICRO
COMPUTER
DRIVE
PULSE

FIG.5.

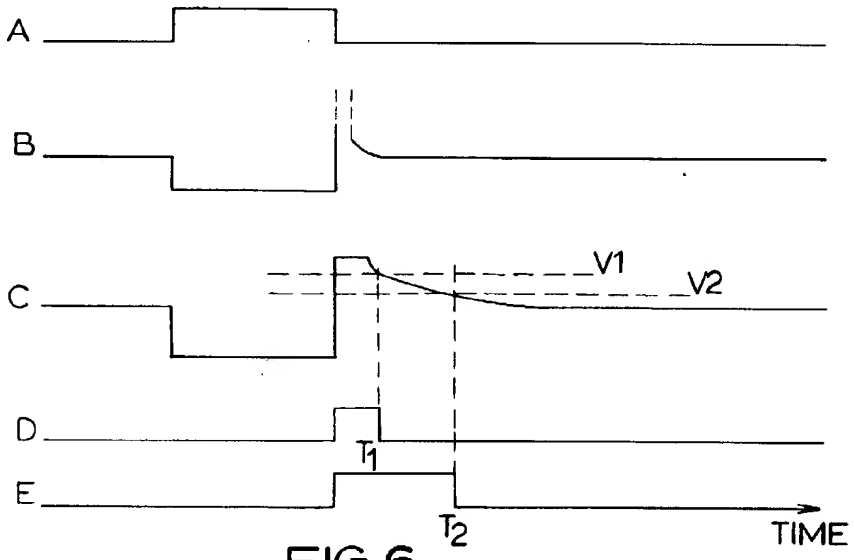
A
B
C
V1
V2
D
T1
E
T2
TIME

FIG.6.